BELL SYSTEM PRACTICES
Outside Plant Construction and Maintenance

SECTION G50.276.1
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AT&T Co Standard

LOCATING UNDERGROUND PIPES AND CABLES

HIGH FREQUENCY METHOD

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1. GENERAL

1.01 This section describes the method of locating, tracing the path and determining the depth of underground conductors such as buried cables, gas and water pipes, buried wire and cable in conduit. It can also be used to locate manhole frames and covers obscured during road surfacing operations or by snow and ice. It is not applicable to submarine cable.

1.02 The method outlined in this section is known as the high frequency method since radio frequency energy of about 130 kilocycles is employed.

1.03 While this section describes the use of the Wilkinson Line Locator, the methods described herein may also be used with other types of high frequency locators such as the Goldak or the Fisher M-Scope.

1.04 This method does not require metallic contact with the subsurface structure, nor the installation of ground rods for application of tracing current. It may be used, therefore, to trace the route of buried power cable, if this is necessary in connection with construction or maintenance work.

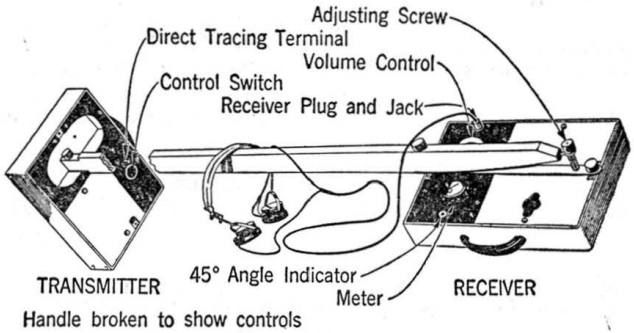
1.05 Where the subsurface structure is available in a manhole or at the surface, or if it is practical to use ground rods, the low frequency method can be used as covered in another section of the Practices.

1.06 Buried cable, buried wire, cable in conduit, buried gas or water pipes, etc., are usually referred to as "conductors" in this section.

2. OPERATION

2.01 There are two models of the Wilkinson Line Locator in the field, the BS and the BS1 which are similar in outward appearance. The description of these two models, and the differences between them are covered in the G86 Division of the Practices.

2.02 The locator is illustrated below:

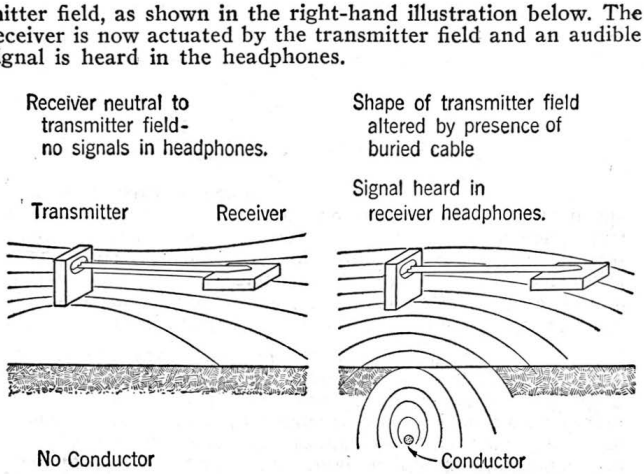


Handle broken to show controls

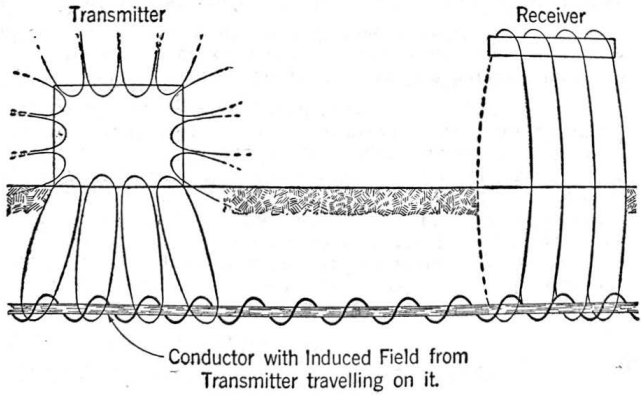
2.03 The theory underlying its operation is outlined below: The transmitter generates radio frequency energy of about 130 kilocycles. This electromagnetic field extends for a considerable distance in all directions from the transmitter and penetrates into the ground to a depth greater than that at which buried and underground cables, buried gas and water pipes, etc., are normally placed. The transmitter field induces a secondary field on any metallic conductors within its influence. This secondary field reacts on the transmitter field to alter its shape.

2.04 When the transmitter and the receiver are mounted on the carrying handle, the electrical plane of the receiver can be adjusted so that it is neutral to the transmitter field, as shown in the left-hand illustration below. When the locator is moved over a conductor, the secondary field which appears around the conductor, will alter the shape of the trans-

mitter field, as shown in the right-hand illustration below. The receiver is now actuated by the transmitter field and an audible signal is heard in the headphones.



2.05 When the transmitter and the receiver are detached from the handle and operated separately, the transmitter is placed on the ground above the conductor to be traced and parallel to it. The receiver will give a signal when it is brought into the induced field traveling along the conductor.



3. LOCATING SUBSURFACE STRUCTURES

Assembly for Use "On Handle"

3.01 Mount the two cases on opposite ends of the carrying handle, using the two long knurled head machine screws which hold the two cases together. The transmitter is fastened rigidly with one long screw to the carrying handle so that the case is perpendicular to the handle. The receiver is fastened to the carrying handle with one long and one short screw, so that the case is parallel to the handle. The spring loaded screw at the receiver end of the handle allows the receiver case to be adjusted with respect to the transmitter until an electrical balance is obtained as described later.

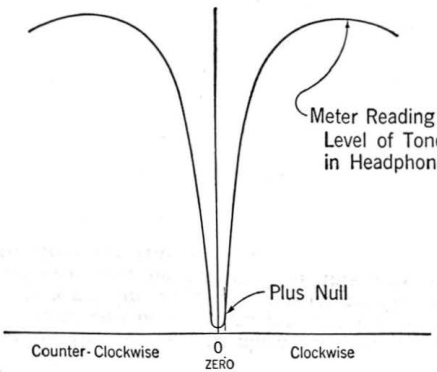
3.02 Before adjusting the set for use "on handle," move to an area free of metal objects where the ground is similar to that where the cable tracing is to be done.

3.03 With the BS model, set the control switch on the transmitter to "NORMAL" and turn the battery switch to "ON." With the BS1 model, turn the control switch to "NORMAL." This automatically turns the transmitter on. Plug in the headphones in the receiver headphone jack. This operation turns the receiver on. Allow the set to warm up for 30 seconds.

Adjustment for Use "On Handle"

3.04 Hold the handle horizontal at the height above the ground at which the locator is to be used. Turn the receiver volume control to a middle setting; a loud tone should now be heard in the headphones. Turn the receiver adjusting screw until the tone in the headphones disappears. At this point the receiver is neutral to the transmitter.

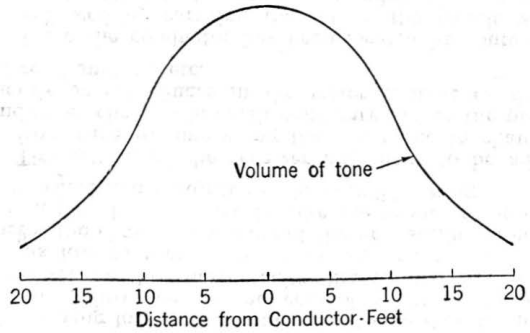
3.05 For best results, the adjusting screw should then be turned clockwise until a slight tone is heard in the headphones; this is known as the "plus null" adjustment. With this setting a slight change in the pattern of the electromagnetic field, caused by moving the locator over a conductor, will cause a large change in volume of tone heard in the headphones, as illustrated below.



Adjustment of Leveling
Screw on End of Handle

Using the Locator "On Handle"

3.06 Following the adjustment for "on handle" use carry the set back to the vicinity of the conductor. Carry the set at a uniform height above and parallel to the ground. Listen for an increase in the volume of tone as the conductor is approached. The volume of tone will increase to a maximum in the headphones as illustrated below, when the locator is at right angles to the conductor and the transmitter is directly above it. The deflection of the meter needle in the receiver will rise and fall with the change in volume of tone in the headphones.



3.07 Having located the conductor it may then be necessary to adjust the volume control on the receiver to a different setting. For best results, the volume control should be set as low as practicable. If in crossing the path of the conductor the change in volume at the new setting is not satisfactory, it may be necessary to take the locator some distance from the cable and readjust the "plus null" setting.

3.08 The setting of the receiver may have to be adjusted from time to time along the route due to changes in soil conditions, changes in earth resistivity due to the presence of minerals or differences in the water content of the soil, type of road surface, etc.

3.09 Once the conductor has been located its route can be followed by carrying the set by the handle with its axis at right angles to the route. It is advisable to cross and recross the conductor from time to time as a check on the tracing and to determine whether readjustment is necessary because of changes in ground conditions.

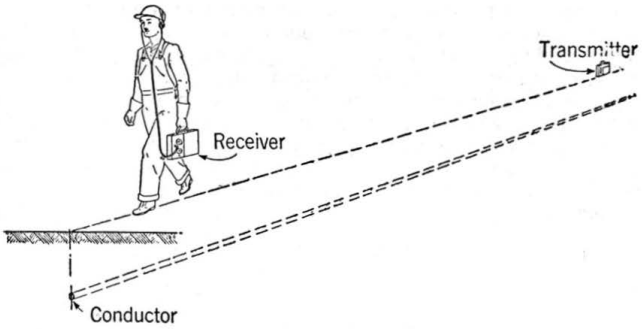
4. TRACING AND DETERMINATION OF DEPTH

Tracing Conductors with Locator "Off Handle"

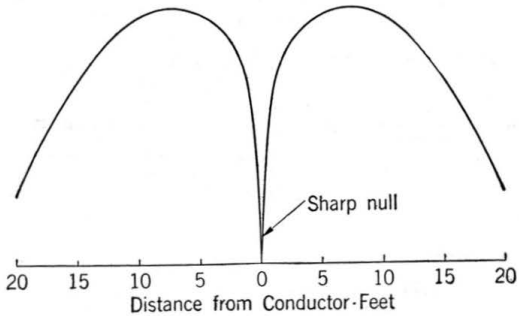
4.01 The transmitter and receiver are removed from the carrying handle and operated as separate units in this method.

4.02 Place the transmitter case on the ground, on end (carrying handle up) parallel to and directly above the position of the conductor as previously determined in Paragraph 3.06.

4.03 Holding the receiver as shown below, the path of the conductor can be followed by keeping the tone in the headphones at a maximum. Under normal conditions up to 500 feet of conductor can be followed in this way before it is necessary to move the transmitter.



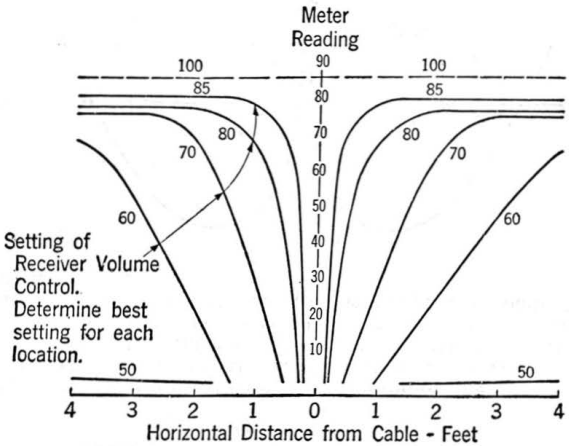
4.04 To determine the exact location of the conductor at any point, turn the receiver from the vertical position to the horizontal and carry it back and forth across the conductor. When the tone heard in the receiver drops to the null point, the center of the receiver is above the conductor, as illustrated.



4.05 The setting of the receiver volume control is used to vary the sensitivity of the set. If the volume control is turned down, the effect is to widen the space in which the conductor can be detected; at the same time the receiver becomes less sensitive and conductors of small diameter might not be noticed. On the other hand, if the volume control is turned up, the effect is to shorten the space in which the conductor

can be detected; at the same time the receiver becomes more sensitive and small conductors deep in the ground can be detected. The drawing below illustrates typical results on a buried cable. The best setting for the volume control should be determined at each location. If the volume control is turned to maximum the receiver may break into continuous oscillation and will be unable to function until the volume control is lowered to a usable value.

Typical Receiver response when held horizontal at waist level



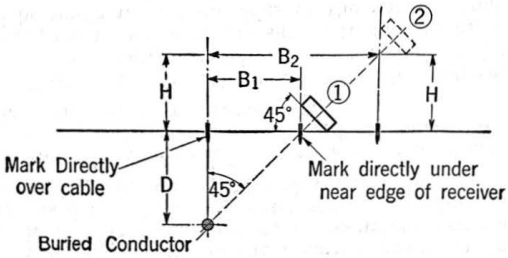
Tracing Conductors "Reverse" Method

4.06 Where two paralleling conductors are closely spaced, say 1 to 5 feet apart, the following method may be used in tracing the conductor which gives the weaker signal. Place the transmitter in the upright position above the conductor giving the strong signal. Walk along the route about 100 feet and set the receiver above the conductor giving the strong signal; then tilt the receiver and block it in the position which gives the minimum signal in the receiver. The receiver will then be neutral to the conductor giving the strong signal. Then pick up the transmitter and carry it across the route, when

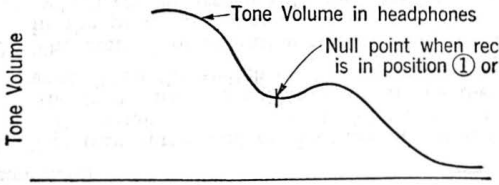
the transmitter is vertically above the second conductor, maximum tone will be heard at the receiver.

Determination of Depth

4.07 After the center of the conductor has been located and marked, tilt the receiver to the 45° angle, as illustrated below. The small angle gauge will center in the ring when the receiver is in the 45° position.



Note: Receiver at position ① then Depth $D = B_1$.
Receiver at position ② then Depth $D = B_2 - H$.



Move the receiver close to the ground at right angles to the route of the conductor until a null point is reached as indicated in the above drawing. At this point a line at right angles to the center of the receiver will pass through the conductor. The depth will be as shown.

4.08 An accurate depth measurement can not be made if the electromagnetic field around a buried cable is distorted by the presence of shield wires or other conductors within about 5 feet of the one being tested. In this case the

depth measurement can not be relied upon if excavations are to be carried out close to or over the buried cable. See Part 5.

Conductive Method of Tracing

4.09 **This method must NOT be used on power conductors.**

4.10 The conductive method of tracing may be used where a pipe or cable is close to a paralleling structure or amongst a network of subsurface structures that interfere with the tracing method previously covered. This method requires a metallic connection to the conductor in order to energize it. A large portion of the transmitter output will travel only on that conductor.

4.11 The transmitter and receiver are operated as separate units. Attach the short ground lead from the binding post on the transmitter to an exposed part of the conductor to be traced. Turn the switch on the transmitter to "Direct."

4.12 The method of operation is the same as that covered in the preceding paragraphs of Part 4, although the distance which can be traced with the receiver is usually less than 100 feet.

5. CONDITIONS AFFECTING USE OF LOCATOR

5.01 When the locator is properly adjusted, no difficulty will be encountered under normal conditions in locating a metallic conductor two inches in diameter buried at depths as much as 8 feet. Small diameter metallic conductors such as shield wires can be identified at plowing depths.

5.02 Subsurface pipes of iron or steel will sometimes give a stronger signal than lead or other non-ferrous metallic structures of the same size.

5.03 From the above, it is apparent that where a buried cable closely parallels a larger water pipe, the water pipe may give a much stronger signal. In such cases, approaches should be made from both sides of the parallel conductors to determine the direction of approach which gives the best indication as the set is moved to a position above the cable. If the location is indefinite from both sides, use the "Reverse" method covered in Paragraph 4.06.

5.04 Short lengths of iron or steel pipe, such as cast-iron bends, U.G. pipe dips, etc., may shield the cable from the locator. In these cases it may be necessary to move the locator beyond the bend or pipe before the cable can be traced again.

5.05 The hum from power lines that is often objectionable in the low frequency method of location, does not affect this locator, although the metal in the lines will have an effect depending on the distance of the lines from the indicator.

5.06 Shield wires plowed in with the buried cable usually do not affect the accuracy of location, but in some cases, for example where two or more shield wires are later placed closer to the surface and perhaps not directly over the cable, the "Reverse" method covered in Paragraph 4.06 should be used to identify the cable. Individual shield wires spaced about 1-1/2 feet or more to the side of the cable can be identified by the "Reverse" method.

5.07 Depth measurements will be affected by the presence of shield wires. Where they are present, the locator will indicate a shallow reading. Where shield wires are present, the actual depth must be obtained by careful excavation if digging or trenching is to be done over the cable.

5.08 Non-metallic conduit can not be identified with this locator, so that where vacant or dead-ended conduit of non-metallic material is present, the low frequency method should be used.